Patent claims

1. A bone replacement material with orthophosphate, characterized in that

a) according to ^{31}P-NMR measurements, said bone replacement material comprises Q_0-groups of orthophosphate and Q_1-groups of diphosphate, the orthophosphates or Q_0-groups making up 65 to 99.9% by weight relative to the total phosphorus content of the finished material and the diphosphates or Q_1-groups making up 0.1 to 35% by weight relative to the total phosphorus content of the finished material, and

b) according to X-ray diffractometric measurements and relative to the total weight of the finished material, 35 to 99.9% by weight of a main crystal phase consisting of $Ca_{10}Na(PO_4)_7$, $Ca_{10}K(PO_4)_7$, mixtures thereof or mixed crystals according to the general formula $Ca_{10}K_xNa_{1-x}(PO_4)_7$, where x = 0 to 1, is contained in the bone replacement material and 0.1 to 25% by weight of a substance selected from the group consisting of $Na_2CaP_2O_7$, $K_2CaP_2O_7$, $Ca_2P_2O_7$ and mixtures thereof is contained as a secondary crystal phase, and

c) the X-ray amorphous phases contained besides the main crystal phase jointly make up 0.1 to 65% by weight relative to the total weight of the finished material.

2. A bone replacement material with orthophosphate, characterized in that

a) according to ^{31}P-NMR measurements, the bone replacement material comprises Q_0-groups of orthophosphate and Q_1-groups of diphosphate, the orthophosphates or Q_0-groups making up 65 to 99.9% by weight relative to the total phosphorus content of the finished material and the diphosphates or Q_1-groups making up 0.1 to 35% by weight relative to the total phosphorus content of the finished material, and

b) according to X-ray diffractometric measurements and relative to the total weight of the finished material, 35 to 99.9% by weight of a main crystal phase consisting of $Ca_{10}Na(PO_4)_7$, $Ca_{10}K(PO_4)_7$, mixtures thereof or mixed crystals according to the general formula $Ca_{10}K_xNa_{1-x}(PO_4)_7$, where x = 0 to 1, is contained in the bone replacement material and 0.1 to 25% by weight of a substance selected from the group consisting of $Na_2CaP_2O_7$, $K_2CaP_2O_7$, $Ca_2P_2O_7$ and mixtures thereof is contained as a secondary crystal phase, and

c) the X-ray amorphous phases contained besides the main crystal phase jointly make up 0.1 to 65% by weight relative to the total weight of the finished material,
obtainable by
mixing raw materials containing (in % by weight) 25-50 CaO, 1-20 Na_2O, 0.5-20 K_2O, 0-13 MgO and 0-10 SiO_2 and treating the aforesaid mixture with H_3PO_4 in an amount corresponding to 30-55 P_2O_5, SiO_2 or MgO or a mixture thereof making up at least 1% by weight, homogenizing and drying the mixture and subjecting it to a step-by-step thermal treatment lasting 1-2h at 350-450°C, 750-850°C and 950-1,050°C respectively, melting the mixture at between 1,550 and 1,650°C, holding it at the melting temperature for between 10 and 60 minutes and finally cooling the mixture in a spontaneous or temperature-controlled manner, grinding it, if necessary, and sintering it to obtain moulded bodies.

3. A bone replacement material according to Claim 1, wherein in addition one or more chain phosphates from the group consisting of $NaPO_3$, KPO_3 and mixed crystals thereof are contained, which chain phosphates are detectable as Q_2-groups according to ^{31}P-NMR measurements, or the orthophosphate ß-tricalcium phosphate, which can be detected as Q_0-groups according to ^{31}P-NMR measurements, or mixtures thereof are contained.

4. A bone replacement material according to Claim 2, wherein the chain phosphates make up 0.5 to 10% by weight.

5. A bone replacement material according to Claim 1, wherein the secondary crystal phase contains a silicate phase corresponding to the SiO_2 content.

6. A bone replacement material according to Claim 1, wherein the crystalline, amorphous or both phases contain magnesium in an amount ranging up to 10% by weight, calculated as MgO and relative to the weight of the finished material.

7. A bone replacement material according to Claim 1, wherein the orthophosphates

makes up 40 to 95% by weight.

8. A bone replacement material according to Claim 7, wherein the orthophosphates makes up 50 to 90% by weight.

9. A bone replacement material according to Claim 1, wherein the diphosphate phase makes up 1 to 22% by weight.

10. A bone replacement material according to Claim 9, wherein the diphosphate phase makes up 5 to 8% by weight.

11. A bone replacement material according to Claim 1, wherein the secondary crystal phase makes up 0.1 to 25% by weight.

12. A bone replacement material according to Claim 11, wherein the secondary crystal phase makes up 1 to 25% by weight.

13. A bone replacement material according to any of Claims 1 through 12, wherein the total solubility ranges between 60 and 250μg/mg relative to the starting material if the test is carried out in 0.2M TRIS-HCl buffer solution at pH = 7.4, T = 37°C using a grain size fraction of 315-400μm, the duration of the test being 120h and the ratio of weighed-in sample to buffer solution being 50mg to 40ml.

14. A bone replacement material according to any of Claims 1 through 13, wherein the coefficient of expansion ranges between 10 and 17 x 10^{-6} K^{-1}, measured using a dilatometer.

15. A bone replacement material according to any of Claims 1 through 13, wherein the pH value of the surface changes by at least 0.3 units, towards the neutral point within the alkaline range if the material is stored in deionized water at room temperature for 72 hours or heated up to 60°C for 1 hour at a pressure of 1-3 bars and rinsed with

deoinized water.

16. A bone replacement material according to Claim 1, wherein said material is provided in combination with a metallic implant surface.

17. A bone replacement material according to Claim 1, wherein in the processed, finished state said material consists of (in % by weight):
35 to 55 P_2O_5; 30 to 50 CaO; 1 to 12 Na_2O; 0.5 to 15 K_2O; 0 to 5 MgO; 0 to 5 SiO_2; SiO_2 or MgO or a mixture thereof making up at least 1% by weight.

18. A bone replacement material according to Claim 17, wherein in the processed, finished state said material consists of (in % by weight):
35 to 55 P_2O_5; 30 to 50 CaO; 1 to 12 Na_2O; 0.5 to 15 K_2O; 0.1-5 MgO; 0 to 5 SiO_2; SiO_2 or MgO or a mixture thereof making up at least 1% by weight.

19. A bone replacement material according to Claim 17, wherein said material consists of (in % by weight) 44 to 54 P_2O_5, 34 to 48 CaO, 1.5 to 10.5 Na_2O, 1 to 11 K_2O, 1.5 to 3 MgO, 0.1 to 4 SiO_2.

20. A bone replacement material according to Claim 1, wherein said material is provided in the form of granulated materials, ceramic bodies or ceramic sheets.

21. A method for manufacturing a bone replacement material comprising ortho-phosphate according to Claim 1, which comprises mixing raw materials containing (in % by weight) 25-50 CaO, 1-20 Na_2O, 0.5-20 K_2O, 0-13 MgO and 0-10 SiO_2 and treating the aforesaid mixture with H_3PO_4 in an amount corresponding to 30-55 P_2O_5, SiO_2 or MgO or a mixture thereof making up at least 1% by weight, homogenizing and drying the mixture and subjecting it to a step-by-step thermal treatment lasting 1-2h at 350-450°C, 750-850°C and 950-1,050°C respectively, melting the mixture at between 1,550 and 1,650°C, holding it at the melting temperature for between 10 and 60 minutes and finally cooling the mixture

in a spontaneous or temperature-controlled manner, grinding it, if necessary, and sintering it to obtain moulded bodies.

22. A method according to Claim 21, wherein the raw materials are divided into two batches and melted separately, the first batch consisting of a melted glass comprising 73-78 SiO_2, 8-11 MgO, 8.5-10 Na_2O, 12-19 K_2O and 0-22 P_2O_5 (in % by weight), which glass is cooled, ground and added to the second batch, i.e. the X-ray amorphous-crystalline material obtained by the melting process of claim 21, in an amount ranging between 0.1 and 15% by weight as a sintering aid and is sintered jointly with said second batch at 900-1,200°C to obtain moulded bodies.

23. A method according to Claim 16, wherein the mixture is melted at between 1,590 and 1,650 °C.

24. A glass used as a sintering aid for resorbable materials comprising calcium phosphates with the exception of β-tricalcium phosphate, wherein the chemical composition in % by weight is:
SiO_2: 73-78;MgO: 8-11; Na_2O:12-19; K_2O: 0-22; P_2O_5: 0-20.

25. A glass according to claim 24, wherein the chemical composition in % by weight is: SiO_2: 74-75;MgO: 8.5-10; Na_2O:14.5-17; K_2O: 0-5; P_2O_5: 0-10.